Argonne NATIONAL LABORATORY

Office of Technology Transfer

Membrane-Based Separative Bioreactor

Operational Benefits and Capital Expenditure Savings in the Bioprocessing Process

2006 R&D 100 Award Winner

BENEFITS

- Convert batch bioconversion processing into continuous processing
- Avoid operational costs associated with reacidification
- Reduce evaporator time and costs
- Increase current production capacity without large capital expenditure
- Design and build new production with one-third of the footprint of conventional bioprocessing

APPLICATIONS

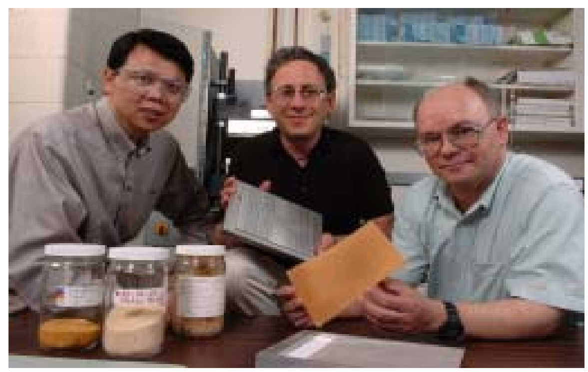
- Bioprocessing of organic acids
- Production of amino acids

STATUS

- Industrial partners to apply this technology to specific bioprocessing application
- Chemical engineering consulting partners to implement this technology

Bioprocessing is receiving increasing industrial acceptance as the economy shifts from dependence on foreign oil and natural gas to crop-based feedstocks. As the market expands to higher volume bio-products, controlling processing costs becomes more critical to commercial success. The costs for product recovery are typically the most difficult to control, because, by nature, biocatalysis is a dilute aqueous process. Products inhibit biocatalysts, limiting concentrations and increasing the costs associated with large volumes of water.

The result is that bioprocessing typically requires significant capital expenditures on energy-intensive steps for product recovery. The Separative Bioreactor research team at Argonne National Laboratory developed a technology platform to address these costs.



From left, Argonne inventors are YuPo Lin, Seth Snyder and Mike Henry. front, left: material to fabricate the resin wafer; center: mold for producing laboratory-scale resin wafer; right: resin wafer that is the core of the bioreactor technology.

The team developed resin wafer technology that is fabricated from commercially available materials. By controlling dimensions, composition, porosity, and conductivity, resin wafer technology can be readily optimized to a target product of choice. Argonne's resin wafers greatly improve the performance of a platform technology called electrodeionization (EDI) that is extensively used to remove charged impurities from aqueous streams. EDI uses electricity to very cleanly and efficiently capture very dilute charged species from process streams. The Separative Bioreactor enables continuous production and removal of charged products, such as organic acids or amino acids, avoiding the requirement to continuously add neutralizing agents.

Argonne researchers integrated biocatalyst immobilization technology into the resin wafer fabrication process to add bioconversion capabilities to the EDI platform. These innovations allow for the immobilized biocatalyst to convert feedstock and simultaneously separate the target organic acid into a product recovery channel.

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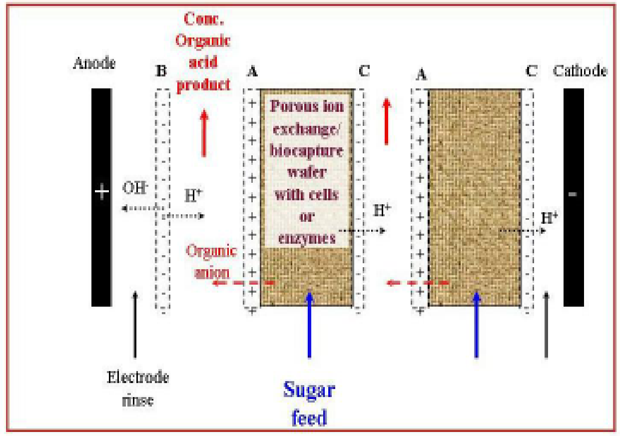
The integrated platform—coined the Separative Bioreactor— enables industrial bioprocessing to economically compete with petrochemical processes. Argonne has a series of patents and pending patents on the device, the fabrication process, the use of the technology platform for several bio/chemical processes, and is seeking partners and applications.



Diagrammitic representation of Separative Bioreactor

The Separative Bioreactor provides several operational benefits to bioprocessing plants. It enables existing batch processes to be replaced by a continuous process with the possibility of increasing throughput. Continuous product capture prevents product inhibition, the limiting factor in batch bioprocessing. In the continuous production of charged biobased products, the Separative Bioreactor avoids downstream unit operations associated with product recovery from the neutralized salts. By increasing product concentration, the Separative Bioreactor reduces the evaporator requirements.

Bioprocessing companies require large capital expenditure to expand or build new production. Conventional plants require numerous fermentors to compensate for the bottleneck caused by batch bioprocessing. By incorporating the Separative Bioreactor into existing plants, production capacity may be increased without the costs associated with expansion. The research team's initial modeling has shown the Separative Bioreactor platform would only require about one-third the footprint of conventional bioprocessing, leading to significantly reduced capital expenditures.

Patents and Published Patent Applications

Electrodeionization method (US 6797140)
Electrodeionization substrate, and device for electrodeionization treatment (US 6495014)
Immobilized Biocatalytic Enzymes in Electrodeionization (US 2004/0060875)
Single stage separation and esterification of cation salt carboxylates using electrodeionization (US 2005/6547A1)
Retention of counterions in the separative bioreactor (US 2006/0065540)
Electronically and ionically conductive porous material and method for manufacture of resin wafers therefrom (US 2006/0063849)
Electronically and ionically conductive porous material and method for manufacture of resin wafers therefrom (WO 2006/033954)
Devices using resin wafers and applications thereof (US 2006/0062988)
Devices using resin wafers and applications thereof (WO 2006031953)

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